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 (72) Inventors GRAHAM WINSTON BRYAN and
 DAVID THOMAS GREEN



(54) ANVIL AND CARTRIDGE ASSEMBLY FOR USE WITH
 SURGICAL LIGATING AND SEVERING INSTRUMENT

(71) We, UNITED STATES SURGICAL CORPORATION, a corporation organised and existing under the laws of the State of Maryland, United States of America, of 10 Light Street, Baltimore, Maryland 21202, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an anvil and cartridge assembly for use with surgical ligating and severing instruments used for ligating tubular organs and severing the organ after placement of the ligatures. Such an assembly can be used with an instrument as described in our co-pending United Kingdom Patent Application No. 10240/71 (Serial No. 1,352,553).

According to the present invention there is provided an anvil and cartridge assembly for use with a surgical ligating and severing instrument, said assembly comprising a pair of parallel rails spaced from one another and terminating at the same end in upstanding anvil portions, a cartridge slidably mounted on said rails and movable from a retracted position to an advanced position in which a front face on the carriage is located close to said anvil portions for clamping thereagainst a tubular organ to be ligated, at least one pair of wire ligatures carried by said carriage in alignment one with each of said anvil portions, a pusher element movably mounted in said carriage and adapted to eject the ligatures therefrom towards and against said anvil portions, and a knife blade mounted in the carriage between said rails and being movable relative to the carriage in a direction parallel with said rails for severing the ligated organ between the two ligatures after the ligating operation, wherein there are provided tissue ejecting means operable after the ligating

and severing operations to eject the ligated and severed tubular organ parts from the anvil portions.

An embodiment of the present invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is an exploded side view of a surgical ligating and severing instrument provided with an assembly according to an embodiment of the present invention,

Figure 2 is a front view of the instrument housing of Figure 1,

Figure 3 is a cross-section through line 3—3 of Figure 1,

Figure 4 is a cross-section through line 4—4 of Figure 1,

Figure 5 is a sectional side view of the instrument of Figure 1 during assembly,

Figure 6 is a bottom view of the drive mechanism of the instrument of Figure 1,

Figure 7 is a bottom view of the cam of Figure 5,

Figure 8 is a view like Figure 5 but showing the instrument fully assembled and with a cartridge assembly in position,

Figure 9 is a view like Figure 8 during a ligaturing operation,

Figure 10 is an enlarged cross-section of the cam of Figure 7,

Figure 11 is a top view of the ligature housing cartridge,

Figure 12 is a cross-section through line 12—12 of Figure 11,

Figure 13 is a cross-section through line 13—13 of Figure 11, and

Figure 14 is a cross-section through line 14—14 of Figure 11.

With reference first to Figures 1 to 4, a basic description of the medical instrument will be given. A hollow casing forms the main body of the instrument and is indicated generally at 10 and is conveniently divided into a cam housing section 12, a drive housing section 14 and a fixed handle section 16. Positioned on the casing 10 is a

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trigger 18 pivotable about a pin 20 and a cam 22 (Figure 5) pivotable about a pin 24. The trigger 18 is connected, through the cam 22, to a cam-engaging a hook 26 (Figure 9), which is defined by a pair of arms 28 rigidly connected together by an alignment bar 30. The bar 30 slides in a slot 32 carved into an elongated guide sleeve 34. The sleeve 34 serves as a housing, support member and guide for a series of biasing springs and pusher rods which act on the associated cartridge assembly to bring about the clamping, ligating, and severing operations.

A drive mechanism 36 is adapted to slide and lock into place in the guide sleeve 34, thereby providing a positive link between the trigger 18 and the disposable anvil cartridge assembly described subsequently in more detail. An inner drive rod 38 extends from a shoulder element 40, through a cartridge mount 42 and terminates in a pair of spaced collars 44 and 46 united by a recess 48.

A second pair of spaced collars 50 and 52 are carried by a hollow outer drive rod 54 extending from the collar 52 through the cartridge mount 42 and terminating at a preset distance from the shoulder element 40. A hollow spacing rod 56, of the same diameter as the rod 54, is located intermediate the end of the rod 54 and the shoulder element 40, the space between the rods 54 and 56 being calculated so as to equal the differential stroke between collars 46 and 50. If desired, the spacing rod 56 could be eliminated by increasing the size of the outer rod 54 accordingly.

The cartridge mount 42 is biased away from the shoulder element 40 by means of a biasing spring 58 extending from an abutment surface 60 in the cartridge mount 42 to the shoulder element 40. A differential spring 62 surrounds the inner rod 38, extends through the rods 54 and 56, and abuts both the shoulder element 40 and an abutment wall 64 integral with the hollow outer rod 54. From Figure 1 it can therefore be seen that the biasing spring 58 maintains the spacing between the cartridge mount 42 and the shoulder element 40. The differential spring 62 exerts a constant force tending to maintain the shoulders 46 and 50 in contact with one another. A shoulder 66 in the cartridge mount 42 serves as a stop when engaging the shoulder 52. In this manner, the relative positions of the elements of the drive mechanism 36 are maintained.

As noted previously, the drive mechanism 36 is adapted to be fitted within the guide sleeve 34. For this reason, the cartridge mount 42 is provided with a pair of locking pins 68 extending into the hollow central region thereof, and adapted to slide within and positively engage one of a pair of locking grooves 70 in the body of the guide sleeve 34. To ensure that the drive mechanism 36 is properly aligned with the guide sleeve 34, an alignment pin 72 is provided on the body of the cartridge mount 42. The biasing spring 58 serves to maintain the locking pins 68 in their respective locking grooves 70.

When the drive mechanism 36 is secured in the guide sleeve 34, the shoulder element 40 abuts the alignment bar 30 integral with the cam-engaging hook 26. The bar 30 is urged toward its rearwardmost position in the slot 32. The hook 26 is held in this position due to the force exerted by the biasing spring 58. Because of the fixed alignment between the arms 28 of the cam-engaging hook 26 and the alignment bar 30, the arms 28 are urged into rest positions defining an angle α with the central axis of the guide sleeve 34.

Insertion of the guide sleeve 34 into the casing 10 will now be described. As seen best in Figure 2, the lower wall 76 of the drive housing 14 contains a depressed region 78. And as seen in Figures 1 and 3, the lower region of the guide sleeve 34 is provided with a projection 80. The projection 80 on the guide sleeve 34 is adapted to comfortably slide in the depression 78 in the drive housing 14. The upper region of the guide sleeve 34 is fitted with a projection 82 having a width dimension substantially greater than the projection 80 and made to approximately the internal width of the uppermost region of the drive housing 14. Hence, the guide sleeve 34 cannot be improperly inserted into the drive housing 14.

In Figure 5, the relationship between the trigger 18 and the cam 22 can be seen. The trigger 18, pivoting about pin 20, is integral with an extension 84 supporting a cylindrical roller 86 adapted to roll about a pin 88. The cam 22 (the bottom of which is shown in Figure 7) is defined by a pair of cam arms 90 rigidly connected to one another by a tubular member 92. The section 84 of the trigger 18 is provided with a first depression 94 and a second depression 96. The depression 94 is adapted to mate with the tubular member 92, and the depression 96 is adapted to mate with the pin 24. The first mating occurs when the trigger is fully depressed and the second when the trigger is released.

When the trigger 18 is in its fully contracted position (Figure 5) the roller 86 has moved along the surface of the cam 22 and the depression 94 has mated with the tubular member 92. It is when the trigger 18 is in this position, that the guide sleeve 34 is ready to be inserted into its drive housing 14.

As seen in Figures 6 and 7, the distance between the arms 28 of the cam engaging hook 26 is approximately equal to the distance between the cam pairs 90. This distance is actually slightly greater than the distance between the cam pairs 90 due to the place-

ment of an engagement disc 98 on each of the cam pairs 90. The cam-engaging hooks are adapted to encounter and grasp the engagement discs 98 when in proper alignment.

5 As mentioned previously, the arms 28 of the cam-engaging hook 26 define an angle α with the body of the guide sleeve 34. The biasing spring 58 exerts a force on the alignment bar 30 and maintains this predetermined angle unless the hook 26 is acted upon by external forces.

10 In Figure 5, the guide sleeve 34 is shown partially inserted into the drive housing 14. A protrusion 100 on each of the arms 28 rotates the arms about the alignment bar 30, this protrusion being of such dimensions to ensure that when the same encounters the lower wall of the drive housing 14, the hook is lifted above and avoids the forwardmost section of the housing.

15 When the guide sleeve 34 is moved a greater distance into the housing 14, the protrusion 100 comes out of engagement with the lower wall of the drive housing 14. And when the hook leaves the surface defined by this wall of the housing, the arms 28 return to their angled rest position. With the arms 28 in their rest position and with the trigger 18 in its fully contracted position, the hooks on the 20 arms 28 are calculated to be in exact alignment with the engaging discs 98. Therefore, when the guide sleeve 34 is further inserted into the drive housing 14, the cam engaging hook 26 carries with it and pivots the cam 22 about its pivot pin 24.

25 When the guide sleeve 34 nears its rearwardmost position in the drive housing 14, a knurled restraining knob 102 is mated with a threaded extension 104 on the rear portion of the guide sleeve. A set of four alignment pins 106 extends from the rear of the cartridge mount 42 and ensures proper alignment between the cartridge mount and the drive housing 14. With the elements then in their rest 30 positions, the instrument takes the form shown in Figure 8.

35 As mentioned previously, the clamping, ligating, suturing and severing operations are done in stages. Each stage requires its own 40 input force for its performance and, for this reason, the cam 22 is employed. The precise operation of the cam will be more fully described below; however, for ease of understanding, the configuration of the anvil and cartridge assembly will first be explained. This 45 will be done with reference to Figures 8, and 11 to 14.

50 The anvil and cartridge assembly is shown generally at 110 and comprises, basically a body made up of three sections, a forward carriage section 112, a thin intermediate support section 114 and a rear cover section 116. Each of these sections is made of plastics and 55 are united to each other by heat-sealing or gluing.

The forwardmost carriage section 112 of the cartridge assembly 110 houses a pair of ligature-carrying cylinders 118, each housing at least one, but preferably twelve, wire ligatures. The cartridge assembly 110 is provided with two anvils 120, spaced from one another and each aligned with a respective one of the two ligature-carrying cylinders.

70 As seen best in Figure 12, the cartridge assembly 110 is provided with a main body 122 sliding in the rear housing section 116 and having embedded therein a pair of pusher rails 124. Each of the pusher rails 124 is adapted to slide in one of a plurality of grooves 126 provided in its associated cylinder 118 and to cause the ejection of a ligature 128 from the cylinder and to curl the ligature against the forwardmost region of the anvil 120. A wire ligature is provided in each of the grooves 126.

75 The main body 122 of the pusher has a downwardly projecting flange 130 sliding within notch 132 and controlling the movement of a knife blade 134. The rest position of the main body 122 is shown in Figure 11. In this position, the flange 130 engages the rearwardmost portion of the slot 132 and holds the knife blade 134 away from the area wherein cutting occurs. When, however, the main body portion 122 is moved toward the 80 anvil, the projection 130 engages the forwardmost part of the slot 132 and urges the knife 134 into the cutting area. Therefore, first a ligature is ejected and formed around the organic tubular structure and then the knife blade moves forward and severs the structure. The length of the slot determines the time delay between the completion of the ligating 85 operation and the initiation of the severing operation.

90 At the upper region of the cartridge assembly 110 is a camming plate 136 associating with a biasing spring 138 and a camming bar 140. The camming plate 136 has a cam slot 142 cut therethrough and is adapted to move in a direction parallel to the longitudinal direction of the cartridge 110. When this occurs, the forwardmost end of the spring 138, projecting through the slot 142 and associating with the camming bar 140, moves in a direction transverse to the longitudinal dimension of the cartridge. Hence, the camming bar 140 simultaneously indexes both of the staple-carrying cylinders 118.

95 To be sure that the spring 138 properly controls the operation of the camming bar 140 and maintains the teeth of the camming bar 140 in engagement with the gears of the cylinders 118, it is necessary that the downwardly projecting region of the spring 138 be biased toward the camming bar 140. Because of this downward bias on the forward region of the spring 138, there is a resulting upward bias on the rearward region of the spring. And, because the cartridge assembly 110 is 100

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constructed of a three-piece construction, the spring 138 tends to urge the individual pieces of the cartridge assembly 110 out of longitudinal alignment. The cartridge assembly 110 is therefore provided with means for maintaining proper alignment between the individual elements of the cartridge, as can best be seen in Figures 11 to 13.

The centrally located support section 114 of the cartridge assembly 110 is in the form of a U-shaped member 144 having a rearwardly extending portion 146 (Figures 11 and 13). The projection 146 has a pair of triangular wedges 148 extending and tapering into the rear housing section 116. In the walls of the rear cover section 116, there are cut a pair of wedge-like depressions 150 adapted to mate with the wedges 148. Because of the wedge shape of these elements, the manufacture of the cartridge is facilitated, and because the wedges 148 mate with the depressions 150 in a direction parallel to the longitudinal dimension of the cartridge assembly 110, the tension of the spring 138 is unable to cause relative motion between the central support section 114 and the rear cover section 116. Therefore, the moving elements of the cartridge 110 are able to freely move.

The cartridge assembly embodies a pair of anvil assemblies 120 movable with respect to the main body of the cartridge assembly 110. The forwardmost part of each anvil 120 has a curved ligature-forming section 152 adapted to unite with a similarly curved section 154 on the forward carriage section 112. In this manner, when the carriage section 112 abuts the anvil sections 120, a tissue gap is defined between the curved region 154 on the carriage section 112 and the anvils. In this way the organic tubular structure is clamped in a position ready for the subsequent ligating and severing.

Naturally, it is important that the organic tubular structure be ejected from the curved section 152 after the ligating, and severing operations are completed. The cartridge assembly is therefore provided with means for ensuring tissue ejection after each complete operation.

As seen best in Figure 11, each anvil section 120 is defined by a series of laminated metallic elements. The central element 156 can be termed a ligature-forming element since it is on this element that the ligature rides and it is this element which defines the final shape of the ligature. Then, positioned on each side of the element 156, is a pair of guide elements 158 ensuring that the ligature is maintained in proper alignment with the ligature-forming element 156.

A fourth element 160, which may be termed a tissue-ejecting plate, is positioned on each of the two anvil assemblies 120 at the outermost regions thereof. As seen best in Figure 12, the tissue-ejecting plate 160 defines a

vertical wall 162 which forces the tissue out of the indentation defined by the curved surface 152 on the anvil assembly 120. A slot 164 in the plate 160 extends in a direction parallel to the longitudinal dimension of the cartridge 110 and mates with a pin 168, extending entirely through the laminate and maintaining the elements integral. The slot 164 thus defines a forward and a rear position for the tissue-ejecting plate 160.

The tissue-ejecting plate 160 extends substantially the full length of the cartridge 110 with its rearwardmost end terminating in a tab extending out of a slot defined in the rear cover section 116 of the cartridge assembly 110. It is the interaction between the slot and the tab which controls both the forward and the rearward movement of the tissue-ejecting plate 160. That is, when the anvil assembly 120 abuts the forward carriage section 112, the tab is put into contact with the rear wall of the slot. In this way, the tissue-ejecting plate 160 is urged out of the indentation in the anvil assembly 120. When, on the other hand, the anvil assembly 120 is at its farthest distance from the main body of the cartridge 110, the tab engages the forwardmost wall of the slot causing the tissue-ejecting plate 160 to force the tissue out of the indentation defined by the curved surface 152.

As explained previously, the cartridge assembly also includes means for locking the moving parts during all stages of transit in positions whereby the cartridge assembly 110 is always ready to be loaded into the basic surgical instrument. The locking means take the following form.

As seen best in Figures 11 and 12, the rearwardmost part of the anvil assembly 120 associates with a mounting block 174. This mounting block is made of plastics, and maintains proper alignment between the laminated elements forming a part of the anvil assembly 120, the knife member 134 and the knife guiding plates 176. A mounting pin 178 passes through the mounting block 174 and holds the metallic laminate elements in place.

Integral with the forwardmost part of the mounting block 174 are a pair of projections 180 having tapered extensions 182 which normally engage in mating grooves 184 formed in the under-surface of the pusher block 122. In this way the relative positions of the movable elements in the cartridge assembly 110 are maintained. The projections 180 are resilient and, therefore, when the cartridge is fired by the instrument, the pointed elements 182 easily come out of engagement with the grooves 184.

The cartridge assembly 110 is mounted on the body of the instrument as follows. The mounting block 174 of the cartridge assembly 110 is moved into engagement with the cartridge mount 42 so that the mounting pin

178 slides into a notch 186 defined in the mount 42. Then a sliding locking element 188 is moved from the position shown in Figure 1 into the position shown in Figure 9. The top surface of the locking member 188 defines a ramp 190 which is adapted to frictionally engage the bottom portion of the mounting plate 174 and to therefore ensure positive locking of the cartridge assembly 110 onto the instrument.

The pusher block 122 defines, at its rearwardmost region, a saddle 192 which, when the cartridge is mounted on the instrument, mates with the recess 48 and is secured therein by the collars 44 and 46. Similarly, the rearwardmost part of the cartridge assembly 110 defines a saddle 194 which is adapted to sit in the depression between the collars 50 and 52. In this manner, and again referring to Figure 1, the main body of the cartridge 110 is connected to the outer rod 54 (being locked between collars 50 and 52), while the pusher assembly, responsible for ejecting and forming the staples around the organic tubular structure, is connected to the inner rod 38 (being locked between collars 44 and 46).

The operation of the instrument is as follows. The rest position of the instrument is shown in Figure 8 and the fully fired position of the instrument is shown in Figure 9. Starting from its rest position, the initial thrust of the trigger 18 moves the main body of the cartridge assembly 110 toward the stationary anvil assembly 120. Before this, the organic tubular structure is positioned within the jaws of the cartridge which are separated by a distance which corresponds to the maximum allowable diameter of the organic tubular structure to be used with the instrument.

When the trigger 18 is depressed a given amount, the body of the cartridge assembly 110 contacts the anvil assembly 120 and the organic tubular structure is securely clamped against the anvils. Then, further motion of the trigger 18 overcomes the force of the differential spring 62 and causes relative motion between the inner rod 38 and the outer rod 54. Then, the pusher assembly is moved in the body of the cartridge assembly 110 and causes the ejection of a pair of ligatures from the cylinders 118 and the formation of the ligatures around the organic tubular structure. Further compression of the trigger 18 moves the knife blade 134 forward thus dividing the organic tubular structure between the placed ligatures.

The different operations described above require different forces for their performance. During the initial movement of the main body of cartridge assembly 110, toward the anvil assembly 120, only the force of the biasing spring 58 must be overcome. When the anvil assembly 120 abuts the forward carriage section 112, the added force exerted by the differential spring 62 comes into play. Still a

greater force becomes necessary when the ligature is bent against the anvil. It has been found that the transmission of these differential forces to the hand of the surgeon is an annoyance to the surgeon, and hence the novel drive mechanism of the present invention was devised.

With reference then to Figures 8 to 10, the operation of the drive mechanism will be described. Depression of the trigger 18 causes the trigger to pivot about its pivot pin 20. And, due to the action of the camming roller 86, bearing against the camming surface 198 on the cam 22, the cam 22 rotates in the direction of arrow 200, thus acting against the force exerted by the biasing spring 58. As mentioned previously, the initial operation of the trigger 18 moves the main body of the cartridge assembly 110 toward the anvil 120. During this operation, the cam roller 86 moves along the region 202 of the cam surface 198.

The cam roller 86 rolls, first in a "downhill" direction and then rolls "uphill". The peak of the first uphill journey of the cam roller 86 is shown at 204. Then, very shortly after the roller 86 passes over the peak 204, the anvil assembly 220 meets the carriage section 112 of the cartridge assembly 110. At this instance the force exerted by the differential spring 62 is added to the force of the biasing spring 58, the combined force opposing the depression of the trigger. The distance along the cam surface 198 corresponding to the time between the initial movement of the main body of the cartridge 110 and the initial contact between the anvil assembly 120 and the main body of cartridge assembly 110, is shown, in Figure 10, at area "1". It will be noted that this area ends shortly after the roller 86 encounters the peak 204 and at a time when the roller 86 is travelling in a downhill direction along the region 206 of the cam surface 198.

The roller 86 then travels downhill while the pusher moves forward, begins an uphill climb while the pusher rails eject a pair of ligatures from the cylinders, and encounters and travels over a second peak 208. This interval is shown as area "2" and represents the time interval between the initial travel of the pusher rail and the instant when the pusher rail brings about the first bending of the pair of ligatures. As seen in Figure 10, the initial bending of the ligatures occurs shortly after the roller 86 encounters the peak 208 and while the roller travels downhill along the region 210 of the cam surface 198.

The area designated "3" represents the interval during which the ligatures bend against the anvil assembly and ligate the organic tubular structure. During the end of this interval, the knife blade divides the tubular structure.

When the cam roller 86 rolls downhill, after encountering a peak in the cam surface

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198, the force required to cause movement in the drive assembly is reduced. That is, the input force necessary to develop a given output force decreases when the cam roller 86 rolls downhill along the cam surface 198. Conversely, the input force required to develop a given output force increases when the cam roller 86 rolls uphill along the surface 198. The cam 22 is shaped in such a manner that the required input force is substantially complementary to the necessary output force. That is, when the output force is required to be high, the cam roller 86 is made to roll downhill, thereby reducing the necessary input force to develop the required output force. Then, when the required output force is low, the cam roller 86 is made to roll uphill so as to increase the required input force to bring about the necessary output force. In this manner, the surgeon is unaware of the changing output demands of the instrument which he uses. The surgeon feels that he exerts a given and constant input force over the entire multi-stage operation.

25 The cam is actually contoured in such a manner that the required input force is gradually increased to "ready" the surgeon for the force transition which is to come. A surge of power is produced when the roller 30 passes a peak and, shortly thereafter (when the surge of power is actually required), the surgeon operating the instrument does not have to physically produce this excess demand. That is, while theoretically the cam roller 86 should 35 pass over the peaks 204 and 208 at the instant when the added output force is required, the transition is moved slightly after the peak so that the surgeon encounters, in practice, what is desired by theory.

40 As can be seen in Figure 6, one of the arms 28 of the cam engaging hook 26 is provided with a pin 212. And, as can best be seen in Figure 5, one wall of the drive housing 14 is provided with an opening 214.

45 A counter 216 may be fitted on the drive housing of the casing 10, engaging the pin 212, and serving to indicate the number of ligature pairs remaining in the ligature carrying cylinders of the cartridge assembly 110.

50 Above, there has been described a single embodiment of the present invention, but it should be appreciated that numerous alterations and modifications may be practiced without departing from the spirit and scope of the invention as claimed.

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WHAT WE CLAIM IS:—

1. An anvil and cartridge assembly for use with a surgical ligating and severing instrument, said assembly comprising a pair of parallel rails spaced from one another and terminating at the same end in upstanding anvil portions, a carriage slidably mounted on said rails and movable from a retracted position to an advanced position in which a front face on the carriage is located close to said anvil portions for clamping thereagainst a tubular organ to be ligated, at least one pair of wire ligatures carried by said carriage in alignment one with each of said anvil portions, a pusher element movably mounted in said carriage and adapted to eject the ligatures therefrom towards and against said anvil portions, and a knife blade mounted in the carriage between said rails and being movable relative to the carriage in a direction parallel with said rails for severing the ligated organ between the two ligatures after the ligating operation, wherein there are provided tissue ejecting means operable after the ligating and severing operations to eject the ligated and severed tubular organ parts from the anvil portions. 65

2. An assembly according to claim 1, wherein in said tissue ejecting means comprise a tissue ejecting plate mounted alongside and parallel to each of said rails and being slideable relative thereto from an inoperative position in which each tissue ejecting plate is spaced from a ligature shaping surface of the respective anvil portion to an operative position in which the plate stands proud of said surface. 70

3. An assembly according to claim 2, wherein the ligature shaping surface has a recess therein in which the tubular organ is received during the ligating and severing operation, said plate in said inoperative position being remote from said recess and in said operative position blocking said recess. 75

4. An assembly according to claim 2 or 3, wherein each tissue ejecting plate is operatively connected to said carriage for movement from said inoperative to said operative position during movement of said carriage along said rails from said advanced to said retracted position. 80

5. An assembly according to any one of claims 1—4, wherein said pusher element also operates through a lost motion mechanism to operate the knife blade after the completion of the ligating operation. 85

6. An assembly according to any one of claims 1—5, wherein the carriage comprises a plurality of pairs of wire ligatures mounted in a pair of ligature magazines and means for feeding successive pairs of ligatures into position in alignment with their respective anvil portions ready for ejection. 90

7. An assembly according to claim 6, wherein in the ligature magazine comprise a pair of cylinders mounted for rotation in said carriage about respective axes parallel with said rails, each cylinder having a plurality of axially aligned grooves in its surface each groove accommodating a wire ligature, and indexing means are provided for rotating said cylinders step by step to bring successive ligature pairs in turn into the ejection position. 95

8. An assembly according to any of claims 100

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1—7 adapted for removably mounting on the instrument body.

9. An assembly according to claim 8, where-
in means are provided to lock the relatively
5 movable parts thereof, when the assembly is
detached from the instrument body, in a posi-
tion for mounting the assembly on the instru-
ment body.

10. An assembly according to claim 8 or
10 9, wherein the locking means operates to main-
tain said pusher element in a fixed position
relative to said rails.

11. An assembly according to claim 10,
wherein the locking means comprises a resilient

catch member biased into engagement with a
groove in said pusher element, the catch mem-
ber being disengageable from said groove upon
application of sufficient force to said pusher
member to overcome said bias.

12. An assembly according to claim 1, sub-
stantially as hereinbefore described with refer-
ence to Figures 11—14 of the accompanying
drawings.

For the Applicants:
D. YOUNG & CO.,
Chartered Patent Agents,
9 & 10 Staple Inn,
London, WC1V 7RD.

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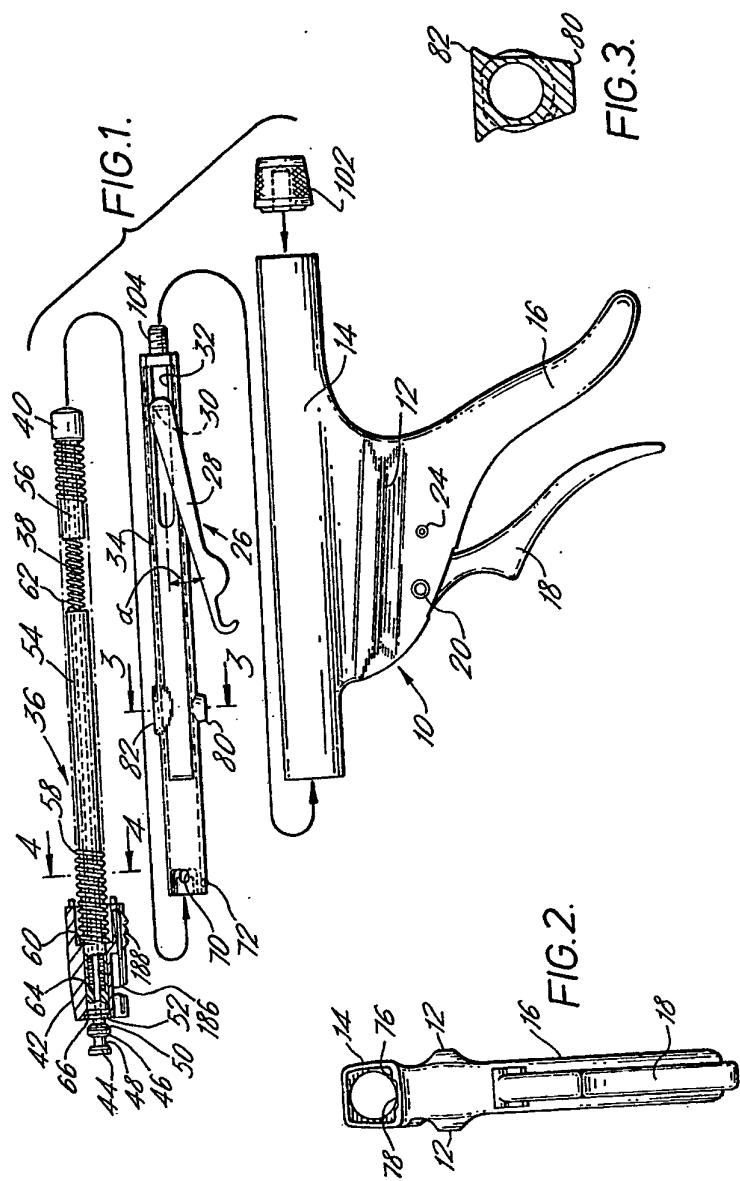
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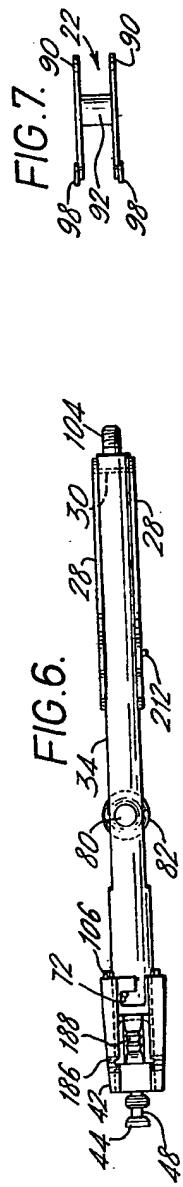
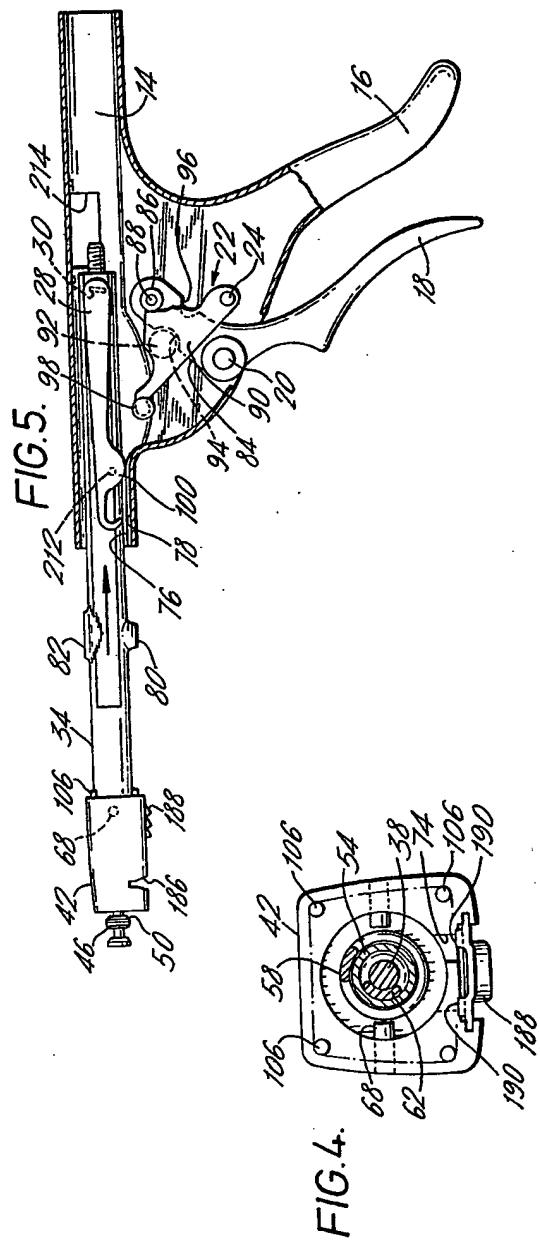
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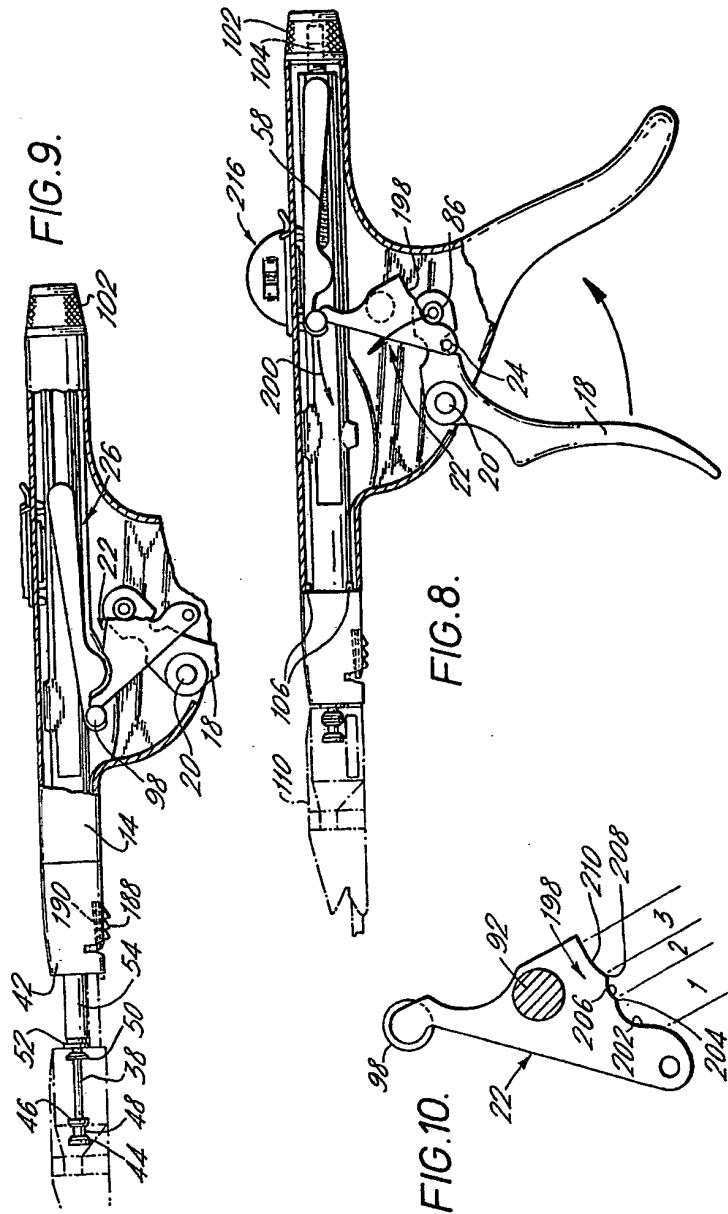
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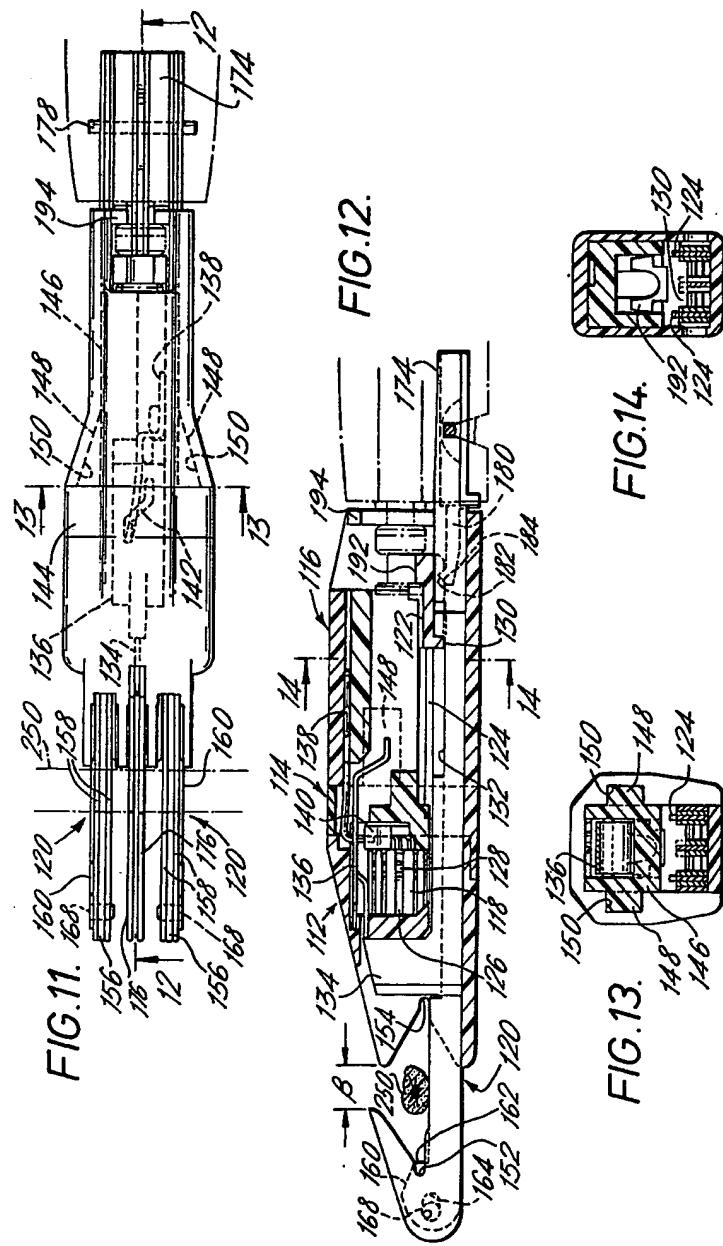
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